



INTERNATIONAL INSTITUTE OF INFORMATION TECHNOLOGY

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Master of Science Programme in Advanced Information Technology (MSP-AIT)

with specialisation in

VLSI and Embedded Systems Design

An autonomous full-time Masters Programme of IIT

The ever-growing IT industry, exceeding a trillion dollars in revenue is founded on the semiconductor chips and the appliances built with them. Over the years, the semiconductor technology has been pushed to sub-micron level and new hardwares are demanding more and more embedded systems designs. The design tools for VLSI have become highly sophisticated and require indepth knowledge of their capabilities. Embedded system design that is required to create innovative products in computing, communications, networking, automotive electronics, power electronics, medical electronics require indepth knowledge of hardware as well as low level software which can be directly embedded on the hardware. This unique programme provides adequate knowledge and imports skills for modern VLSI design and embedded technologies.

THE PROGRAMME

This four trimester full-time Masters programme with specialisation in VLSI and Embedded Systems Design is conceptualised, developed and delivered by experts from the VLSI and Embedded System industries under the inspiring guidance of an internationally acclaimed panel of visionary leaders and innovators of the IT industry. It is designed to cater to the emerging market needs by providing practical knowledge of VLSI and Embedded technologies focusing on the design and implementation techniques.

DISTINCTIVE FEATURES

- Laboratory sessions to gain experience of projects
- Exposure to PLD programming and verification kits and PLDs such as CPLD & FPGA
- Exposure to industry standard tools such as ModelSim, Leonardo Spectrum, HDL Designer, Xilinx - ISE Series, etc

ELIGIBILITY

- Graduates with a Bachelor's Degree of minimum three years' duration in Electrical/Electronics/Communication/Information Technology/Computer Science or equivalent
- Students appearing in their final year of graduation may also apply
- Sound background in computing, knowledge of C preferred
- See insert on "Selection and Admission Procedure" for more details

COURSE COMMENCEMENT

The course commences in June / September / January

EVALUATION AND CERTIFICATION

- Periodic evaluation and performance improvement programme
- Module-wise credits
- Balanced assessment based on internals, examination and project
- Detailed transcripts along with certificate

PLACEMENT ASSISTANCE

- Career guidance at the institute
- Pre-placement facilitation/development
- Active liaison with companies in Infotech Park
- Campus interviews by leading industries in India

CURRICULUM

COMMON FOUNDATION PROGRAMME

- **Self-Management and Leadership**
This module helps the students to understand one's self and to develop leadership qualities. The student will be taught Yoga of well being, meditation techniques, the Art of Living, self management and leadership, team building, sports, gym and creative arts.
- **Foreign Language**
This module is designed for students aspiring to learn a foreign language for business communication to avail of global career opportunities. English language course will be a pre-requisite for foreign students who do not have adequate proficiency in English.
- **ICT Business Management**
The course provides students with basic management skills for performing in Information & Communication Technology and a high emphasis on computer usage and office productivity and project management. The topics include applying principles of effective communications, time management, interpersonal skills project management, product management, innovation management and finance management.

TRIMESTER I

COMMON CORE PROGRAMME

- **Computer Architecture**
This module focuses on the study of the hardware structure of computer systems and subsystems. Topics include: processor architecture, parallelism and pipelining, cache and memory organisation, I/O controllers and interconnection structures.
- **Theory of Operating Systems**
This module covers operating system design concepts with examples from the Linux and Windows operating systems. The topics covered (tentatively) include operating system structures, process and thread management, process synchronisation and communication, memory management, virtual memory, file system, I/O subsystem and device management, communication, protection and security.

● Database Technologies

This module focuses on the theory of database engineering. The module includes topics like file processing, some introductory data structures, the differences between file processing and database processing, fundamental concepts of the relational model, normalisation of data, database integrity issues, database design, SQL and an overview of the functions of a database management system.

● Data Communication and Networking

In this module, the emphasis will be on developing an understanding of the underlying principles of data communications and networking. The student will learn the concepts and terminology of data communications and networking. It covers topics on communication models, network protocols, standards, LANs, WANs, the internet, intranet and networking applications.

TRIMESTER II

ADVANCED TECHNOLOGY PROGRAMME I

● Analog and Digital Design

This module focuses on learning analog components and analog circuit design, digital circuits, combinational logic designs, sequential logic designs and state machine designs.

● VHDL Hardware Description Language

This module focuses on learning syntax, entities, data types, sub-programmes, packages, libraries, structural modeling style, data flow modeling style, behavioral modeling style, sequential and concurrent statements, advanced topics and synthesis issues of VHDL.

● Verilog Hardware Description Language

This module focuses on learning syntax, data types, modules and ports, gate level modeling style, data flow modeling style, behavioral modeling style, switch level modeling style, task and functions, UDPs, advanced topics and synthesis issues of verilog.

● Theory and Practice on Programmable Devices

This module focuses on learning PLD design flow and design implementations, principles of synthesis process, back-end activities like place and route, back annotation and timing simulation of HDL codes.

● Principles of CMOS VLSI Design

This module focuses on learning basic MOS, NMOS, PMOS, CMOS, Bi-CMOS fabrication and electrical properties, CMOS circuits and logic design, MOS transistor processing technology, MOS transistor theory and CMOS gates of digital VLSI design in CMOS technology. Topics include: CMOS devices and circuits, fabrication processes, static and dynamic logic structures, chip layout, simulation and testing, low power techniques, design tools and methodologies and VLSI architecture.

● Low Power Mixed-Signal VLSI Design

This module focuses on the basics of designing mixed analog and digital logic design. The topics to be covered include low voltage, low power analog design for mixed analog/digital VLSI systems in CMOS technologies, OpAmps and comparators, sample and hold, switched capacitor filters, applications in baseband wireless communications and integrated sensors.

TRIMESTER III

ADVANCED TECHNOLOGY PROGRAMME II

● Designing with Micro Controllers

The architecture, programming and hardware interfacing of 8-bit and 16 bit micro controllers are discussed. The students will learn how to design systems/products based on 8/16-bit micro

controllers. Students will be able to analyze the timing issues involved in designing a micro controller based application.

● Embedded System Design

In this module, embedded system hardware and firmware design will be explored. Issues such as embedded processor selection, hardware/firmware partitioning, glue logic, circuit design, circuit debugging, development tools, firmware architecture, firmware design, and firmware debugging will be discussed.

● Real-Time Operating Systems

This module focuses on the principles of real-time operating systems. The module aims to prepare the students to design and implement real-time application, understand the functionality of a real-time operating system and use RTOS for application development. The topics include operating systems basic concepts, hardware and software features required for real-time systems, process management, scheduling, inter-process communication and synchronisation, memory management, virtual memory and distributed systems.

● Digital Signal Processing

This course provides students with solid foundation on the theory and applications of digital signal processing. Fundamental and advanced mathematical and physical DSP concepts will be discussed. Topics include signals, signal processing, discrete-time signals, systems in time domain, Discrete-Time Fourier Transform (DTFT), DFT, Z-transform, transform analyses of Linear Time Variant (LTI) systems, A/D, D/A converters, digital processing of continuous time signals, digital filter design, FFT, the digital spectral analyses and theory and applications of non-uniformly sampled signals.

● Introduction to Network Programming

This module prepares the students with network programming concepts and developing applications under Linux/Windows environment using sockets. The topics include networking, TCP/IP protocol suite, sockets programming, internet protocols, WAP web programming, security and network programming APIs.

● Advanced Topics in Embedded System Design

This module introduces fundamental concepts in hardware/software co-design of embedded systems, exposing students to the cutting-edge research work and the emerging trends in related topics and provide students with research experience in embedded system design and analysis. The main topics include system modeling, performance and power/energy analysis and estimation, system-level partitioning, synthesis and interfacing, co-simulation and emulation. Research papers with significant impacts on the above topics are studied in detail. Class discussions, participation and research project are integral parts of this module.

TRIMESTER IV

RESEARCH PROGRAMME

The research programme leading to masters level competency includes researching on the given/chosen seminar topic, which will generally be a state-of-the-art in the field, and then delivering the seminar to peer and faculty along with its documentation in the prescribed IEEE format. Following the seminar the student has to undertake research project under the guidance of tenure/visiting faculty/industry experts. The research project has to be submitted in the form of a dissertation, which will be examined by the experts nominated by the institution. The research project is the culmination of students learning in the institute and is expected to be of high standards, as demanded from the institute from time to time.

The Institute reserves the rights to change / revise the course contents as per the prevailing market conditions and technological advances.



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Master of Science Program in Advanced Information Technology (MSP-AIT)

with specialization in

Advanced Embedded Systems Design

An autonomous full-time residential Master's Program (18 months)

"Everything will be connected, and I mean literally everything. Not just electronic devices, but everything down to your piano. We'll have as many as four or five (embedded) Internet devices on our bodies."

— John Chambers

Recent developments in embedded systems are spanning new applications in computing, communications, networking, automotive electronics, medical electronics, avionics and the like. A three-dimensional growth is taking place in this high-end technology sector, with increasingly powerful micro-controllers and digital signal processors competing with emerging tools in field programmable gate arrays (FPGAs). Embedded systems range in size from cell phones and mini-robots to large-scale systems deployed in process control, manufacturing, power generation, defense systems, telecommunication systems, automotive systems, air traffic control, video-on-demand and video-conferencing and actually account for more than 90 percent of the manufactured processors. India is emerging as a global embedded design and software destination due to its cost advantages and emerging talent pool in this domain. Demand is continuing to outstrip the availability of highly skilled pool of graduates for the fast evolving embedded systems industry. This program introduces students both, to the state-of-the-art and state-of-the-practice in the broad field of embedded and real-time computing, control, and communication and enables them to pursue rewarding careers in these frontier areas of technology.

THE PROGRAM

This four-trimester, 18-months, full-time Master's program in Advanced Embedded Systems Design is designed to equip the students to gain industry oriented technical knowledge and also imparts hardcore skills in the high-end technologies incorporated in the area related to embedded systems. This curriculum starts with introductory concepts in hardware and software, and incorporates an essential knowledge base of hardware and software co-design along with application specific embedded design concepts.

PROGRAM STRUCTURE

- Successful completion requires 60 credits.
- To bridge the gap between theory and practice, project work of 15 credits is incorporated in the last semester.
- The entire curriculum is categorized into five levels of increasing complexity and corporate readiness. The levels respectively are Basic, Foundation, Core, Concentration, Electives and Project.
- The student has to carry out at least one mini project in the specified trimester to consolidate the technical knowledge in selected specialization stream.

PROGRAM PEDAGOGY

All courses are designed to address the key areas like theoretical foundation, practical relevance and the real life problem solving approach. To achieve that, courses will be delivered using collaborative learning processes through class room lectures, laboratory sessions, assignments, student seminars, lectures by industry experts, case studies, relevant industry visits and research / industry projects.

DISTINCTIVE FEATURES

- Exposure to state-of-the-art micro-controllers, digital signal processors and programmable logic arrays in the laboratories.

- Coverage of all the above three embedded system domains.
- Development experience in Linux environment.
- Application specific course design.
- Flexibility in the choice of project domain
- A choice of research or industry project.

ELIGIBILITY

- Graduates with a Bachelor's Degree (with minimum 50 percent marks) of at least four years' duration in Electrical/Electronics/Communication / Information Technology/Computer Science or equivalent.
- Good computing background in C and C++ programming languages preferred.
- See insert on "Selection and Admission Procedure" for more details.

PROGRAM COMMENCEMENT

The program commences in June / September/ January.

EVALUATION AND CERTIFICATION

- Continuous evaluation and performance improvement program
- Course-wise credits
- Balanced assessment based on internals, laboratory and final theory examinations and project
- Detailed transcripts along with certificate

PLACEMENT ASSISTANCE

- Career guidance at the institute
- Pre-placement facilitation/development and Campus interviews by leading industries
- Active interface with technology and user companies

BASIC COURSES

● COM001: LIFE SKILLS DEVELOPMENT

This basic course prepares students for the rigours of the master's level program and professional careers that will follow. The course is divided into 9 sections that will be conducted throughout the program.

The course stresses on: communication and presentation, leadership development, working in teams, time management, negotiation skills, stress management through yoga, multicultural and diversity management and offsite experiential learning. The ultimate objective of this course is to develop individuals with high Intelligence, Emotional and Spiritual Quotients (IQ, EQ and SQ).

● COM002: FOREIGN LANGUAGE (LEVEL 1)

In order to equip students to take up global careers, a choice of a foreign language as a major subject is offered. Medium of instruction is English.

BRIDGE COURSES

- Keeping in view the diverse background of students, variety of bridge courses are offered to attain the requisite level of competency for further learning.

- Students will undergo an entrance examination and an interview as a part of selection process. Depending on the performance, students will be advised to undergo bridge course.

- Duration of the bridge courses is 4 weeks prior to the beginning of the academic term.

● AST 001: COMPUTER ARCHITECTURE AND OPERATING SYSTEMS

This course covers operating system design concepts with examples from Linux and windows operating system. It also focuses on the study of the hardware structure of computer systems and sub-systems.

The topics in operating system include: Operating system structures, Process and thread management, Memory management Virtual memory, File system, I/O subsystem and device communication. Protection and Security management. The topics in computer architecture include: Processor architecture Parallelism and pipelining, Cache and memory organization, I/O controllers and interconnection structures.

● MV003: INTRODUCTION TO LOGIC DESIGN

This course covers binary and non-binary systems, boolean algebra, digital design techniques, logic gates, combinational circuits, K maps, flip-flops, sequential circuits and state machine theory. This course also includes preliminary timing analysis, digital circuit building blocks such as multiplexers, decoders, counters, PLA, PAL, PLD, various logic families, I/O standards, bipolar based logic; ECL, BiCMOS, memory; SRAM, DRAM, EEPROM, and I/O circuits.

FOUNDATION COURSES

● ESD501: ANALOG AND DIGITAL SYSTEMS DESIGN (3 Credits T=2 L=1)

This course covers digital circuit, CMOS logic circuits, combinational logic design, logic building blocks, idioms, and structured design, sequential logic design and timing analysis, clocks and synchronization, finite state machines, microcode control, digital system design, control and data path partitioning, designing digital and analog printed circuit boards.

● ESD502: MICRO COMPUTER BASED SYSTEM DESIGN (3 Credits T=2 L=1)

This course is designed to introduce 8-bit/16-bit micro-controllers and also covers RISC/ CISC, Harvard/ Princeton architectures, timers/ counters, UART, SPI, PWM, WDT, input capture, output compare modes, I2C, CAN, interfacing, I/O, switches, ADC, DAC,

LCD, RTC, emerging bus standards (USB, Compact PCI), types of memories, programming in assembly and C (GNU Tools).

● ESD503: DIGITAL SIGNAL PROCESSING (3 Credits T=2 L=1)

This course introduces the basics of discrete-time signals and systems, and covers the system characterization in time and frequency domains, discrete-time Fourier transform (DTFT), DFT, FFT, Z-transform, A/D, D/A converter, digital signal processing of continuous time signals, digital filter design (FIR and IIR), digital spectral analyses of signals, and application of non-uniformly sampled signals. This module also includes software implementation of DSP algorithms.

● ESD504: ADVANCED C PROGRAMMING (3 Credits T=2 L=1)

This course introduces the fundamentals of C programming, data structures, implementation of numerical algorithms, real-time concepts, and the use of macros. Lab sessions involving implementation of algorithms in C are included.

● ESD505: ADVANCED TECHNOLOGY SEMINAR SERIES (1 Credit)

This course includes seminars by experts from industry and academia providing introduction to advances and possibilities in the advanced technology. Students are given a bird's eye view of multiple technological frontiers.

CORE COURSES

● ESD601: EMBEDDED SYSTEMS DESIGN (3 Credits T=2 L=1)

This course covers the embedded system design issues, challenges and trends in embedded systems, assemblers, compilers, linkers, loaders, debuggers, profilers & test coverage tools, utilities like make, ranlib, objcopy and objdump, configuring and building GNU cross-tool chain, and building RTOS/ EOS image for target hardware. It also includes porting RTOS and embedded operating systems, writing time and space sensitive programs, and writing device drivers

● ESD602: REAL-TIME OS (3 Credits T=2 L=1)

This course covers the principles of real-time operating systems, design and implementation of real-time applications, real-time operating system development, operating system basics, hardware software features required for real time systems, process management, scheduling, inter-process communication and synchronization, memory management, virtual memory and distributed systems.

● ESD603: EMBEDDED DESIGN CYCLE (2 Credits)

This course introduces fundamental aspects of embedded systems design, implementation and testing, project management, hardware development life cycle, software development life cycle models, verification and validation process for complete embedded systems.

● ESD901: MINI-PROJECT (2 Credits)

This course is designed to introduce the complete design cycle of software or hardware in the development of an embedded system. An internal faculty guides the project. The project has to be submitted in the form of a report including the detailed literature survey that will be examined by experts nominated by the institute.

● ESD605: EMBEDDED DIGITAL SIGNAL PROCESSORS (3 Credits T=2 L=1)

This course introduces the design path of a (digital) signal processing system, determining a suitable filter approximation, choosing the correct filter structure for limit cycle suppression and minimization of quantization noise, applying multi-rate signal processing techniques, and using design software. Emphasis is placed on efficient implementation using various sample frequencies (multi-rate DSP). Complex filtering and filter banks are introduced. C language based Compilers for Texas Instruments, Analog Devices, and Motorola DSPs are utilized.

- **ESD606: TECHNOLOGY & IP MANAGEMENT (1 Credit)**

This course provides an introduction to Indian and global IP practices with specific focus on embedded software. Case studies from different application disciplines are also presented.

ADVANCED COURSES

- **ESD701: ADVANCED MICRO-CONTROLLER BASED SYSTEM DESIGN (3 Credits T=2 L=1)**

This course introduces 16-bit/32-bit processors, ARM/ Rabbit / Intel architecture and organization, ARM - THUMB/ Rabbit programming model, ARM - THUMB/ Rabbit instruction set, ARM/ Rabbit exception handling, ARM - THUMB/ Rabbit assembly and C programming (GNU Tools), and ARM - THUMB/ Rabbit communication protocols.

- **MV701: DIGITAL SIGNAL PROCESSING WITH FPGA (3 Credits T=2 L=1)**

This course covers the introduction to FPGA technology, FPGA design of IIR filters, FPGA design of FIR filters, FPGA design of Fourier transforms, advanced design concepts—Fourier related transforms, rectangular and number theoretic transforms, error control and cryptography, modulation and demodulation, downloading and testing of DSP blocks with suitable FPGA boards, IP cores and Glue logic concepts.

- **ESD703: EMBEDDED LINUX (3 Credits)**

This course covers different types of host and target systems, architecture of target board, types of boot configurations, different development tools, kernel selection, compilation and installation, root file system, modules, setup, storage devices, bootloaders, memory management, debugging tools, device drivers, I/O—character, block, net drivers, real time scheduling.

- **ESD704: ADVANCED EMBEDDED SYSTEM DESIGN SEMINAR SERIES (1 Credit)**

Students are required to present a seminar on relevant topics in embedded application domain for campus-wide audience.

ELECTIVES

- **ESD801: ADVANCED DIGITAL SIGNAL PROCESSING (3 Credits)**

This course covers various emerging techniques in the area of digital signal processing such as multi rate signal processing, multidimensional signal processing, short-time Fourier transform, signal expansion in discrete and continuous time, filter banks, multi-resolution analysis, wavelets and their applications to image compression, wavelet transform, high performance digital signal processors, benefits of these DSP's to wireless infrastructure, base band processing and packet telephony applications. Relevant case studies or mini-project will have to be done demonstrating the programming skills.

- **ESD802: EMBEDDED COMMUNICATION SYSTEMS (3 Credits)**

This course gives an overview of networking and packet switching concepts, OSI reference model and TCP/IP protocol suite, serial

communications programming, HDLC, X.25, Frame relay, ATM, DSL, ADSL, LAN protocol suite, application layer protocols, embedded network protocols: issues and applications, embedded internet appliances, and wireless protocols (802.11, bluetooth). Further issues covered include security in embedded systems, video and audio standards and technology trends.

- **ESD803: EMBEDDED WIN-CE (3 Credits)**

This course provides an overview of Windows CE operating system. It also introduces the Windows CE architecture, Windows CE kernel, processes and threads, scheduling, priority inversion, memory architecture, and graphics, windowing and event subsystem (GWES).

- **ESD804: SPEECH SIGNAL PROCESSING (3 Credits)**

This course covers human speech production and perception, speech units, acoustic-phonetic analysis, Fourier spectra, timbre, spectrograms, formant trajectories and timing, and prosody. This course also covers parametric representation of speech, LPC analysis and resynthesis, automatic determination of pitch and voicing, speech coding, manipulation of pitch, timing and timbre, voice conversion, digital models and implementations. Typical embedded speech applications are introduced.

- **ESD805: DATA FUSION TECHNOLOGIES (3 Credits)**

This course introduces 1-D, 2-D and 3-D Data representation, audio, music, image and video storage and transmission formats, advanced transforms for data visualization and data compression—discrete cosine transform, discrete wavelet transform, principles of sampling and data acquisition for signals and images, and also introduces simple filtering algorithms for images.

PROJECT

- **ESD902: PROJECT (15 Credits)**

Students can take up an industry-sponsored project or a research based in-house project leading to Master's level competency.

For industry-sponsored projects, the Career Management Center facilitates interaction between students and the industry. Students are encouraged to work on projects that will enhance their understanding in certain technology domains in a real-life scenario.

The research project includes researching on the given/chosen seminar topic that will generally be state-of-the-art in the field and then delivering the seminar to peers and faculty along with its documentation in the prescribed IEEE format. Following the seminar the student has to undertake a research project under the guidance of tenure track/visiting faculty/and industry experts. The research project has to be submitted in the form of a dissertation that will be examined by experts nominated by the institute. The research project is the culmination of the student's learning in the institute and is expected to be of high standards as demanded by the industry from time to time.

TOTAL COURSE CREDITS : 60

NOTE : Foreign language is an independent certificate program, compulsory for all students.

